Space Weather Technical Forecast

Issued on Monday, 21 August 2023 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Low, with the peak flare reaching C3.7 at 20/0626 UTC from a very small sunspot in the northwest, AR3409. Background X-ray flux has otherwise been subdued, but is now increasing as a large sunspot group (Ex-3386) is rotating over the eastern horizon in the northern hemisphere. There are currently seven sunspot regions on the facing side of the Sun, with little overall change in the sunspots which were generally magnetically simple and stable. AR3404 in the southwest has faded and AR3403 (Cso/Beta) and AR3405 (Hsx/Alpha) have both seen their trailer spots decay. Nominally, the greatest risk of significant flares is AR3407 (Dso/Beta) but this region has been inactive.

No Earth-directed CMEs were observed during the period.

Solar Wind / Geomagnetic Activity: The solar wind as measured by DSCOVR and ACE at L1 started at Elevated levels around 500-550km/s, but has increased during the period to reach 600-670km/s (Strong) with a peak of 690 km/s noted at 20/1200 UTC. This initially was thought to be due to the influence of CH35/-, but after further analysis of current and past coronagraph imagery suggests a previously unidentified trans-equatorial, negative polarity coronal hole currently located around 50W. The density of particles carried by the solar wind was mainly at below average levels, with a brief peak of 5ppcc (average) recorded at 20/1958 UTC. The phi angle was accordingly almost exclusively negative (towards the Sun). The magnetic field, IMF (Bt) was Weak to Moderate at the start of the period with a peak of 10nT at 20/0525 UTC. Since 20/0800 UTC the IMF has mostly been Weak, with only very brief increases to Moderate. The north-south component, Bz, ranged between +9 and -6nT, with a positive bias overall. The net result of the above solar wind measures was for Quiet to Unsettled geomagnetic activity (Kp1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels. GOES16 high energy (greater than 2MeV) electron flux ranged from Moderate to Normal Background levels, with the associated 24-hour fluence well below the Active level, with an observed value of 1.26e6 integrated pfu at 21/0001UTC, on a flat then generally declining trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is expected to be mainly Low, but with a Chance of isolated M-class flares. There is a greater chance of activity this week compared to last with the arrival of some far-sided regions, which includes a previously active sunspot that was responsible for an X-flare on 05 August.

Solar Wind / Geomagnetic Activity: Solar winds at L1 are currently enhanced (to Strong levels) by a previously unidentified negative polarity, trans-equatorial CH in the western hemisphere. The connection to this feature should ease in the next couple of days (to Elevated or Slightly Elevated levels) before the arrival of another CH on Day 3 (23 August) likely increases speeds to more persistently Elevated levels once again. This feature then probably

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

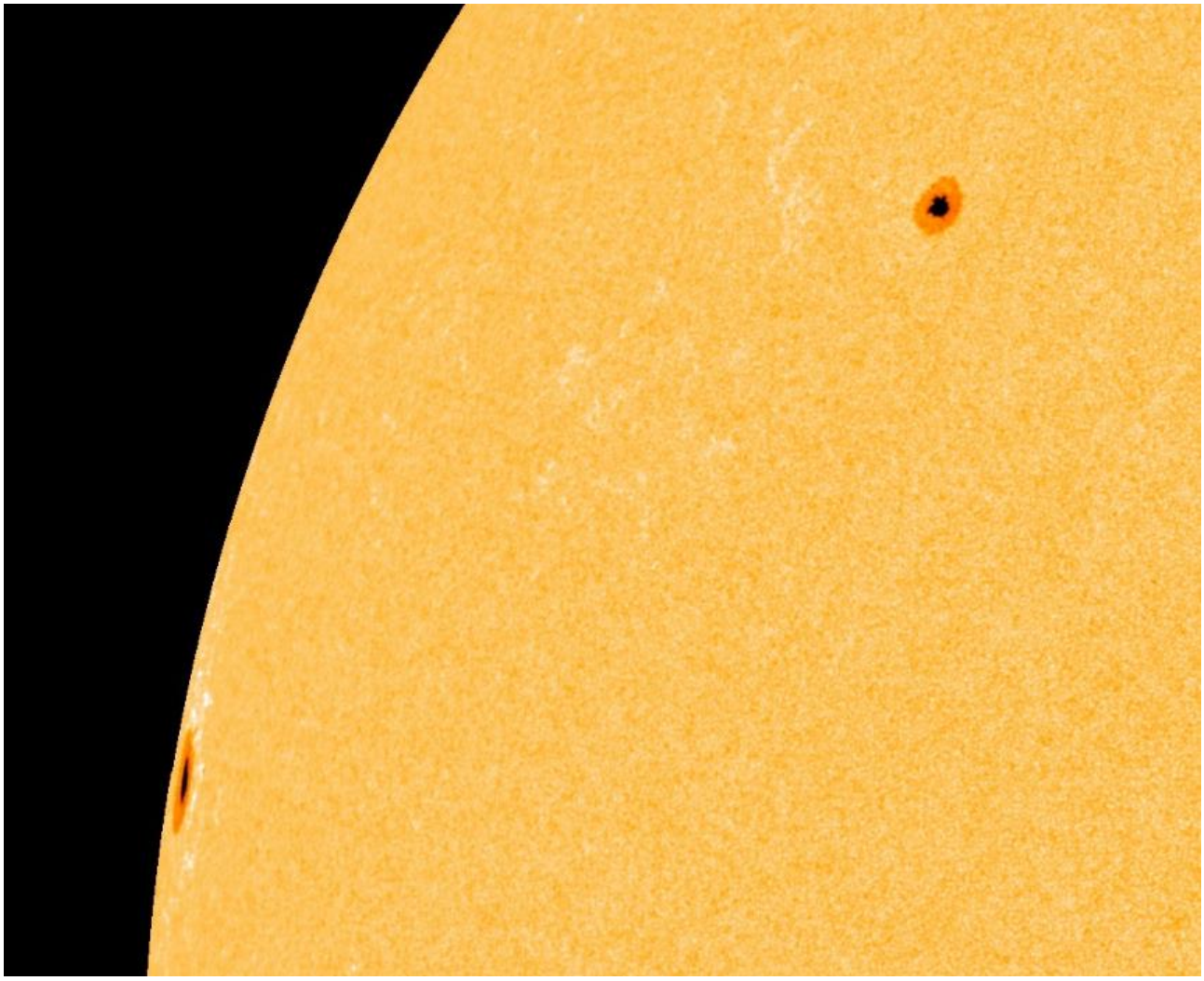
© Crown Copyright 2023. All Rights Reserved.

eases on Day 4 (24 August). No Earth-directed CMEs feature in the forecast.

Geomagnetic activity is forecast to be mostly Quiet to Unsettled (Kp1-3) throughout, but on Day 1 (21 August) and also Day 3 there is the Chance for isolated Active intervals and a non-zero risk of a G1/Minor Storm period should there be any protracted period of negative Bz on these days, especially given the enhanced solar winds indicated.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels. High energy electron flux (greater than 2MeV) will probably show an increase in the coming days as the HSS from the current CH wanes, with diurnal peaks reaching Moderate, possibly High values. Confidence in the forecast reduces from Day 3 (23 August) onwards with a new CH expected to reduce electron counts, probably continuing into Day 4 (24 August). The associated 24-hour fluence will start below Active (1e8 integrated pfu), but with a probable upward trend in coming days giving a Slight Chance of reaching the Active threshold on Day 2 (22 August), increasing to a Chance on Days 3 and 4 (23 and 24 August).

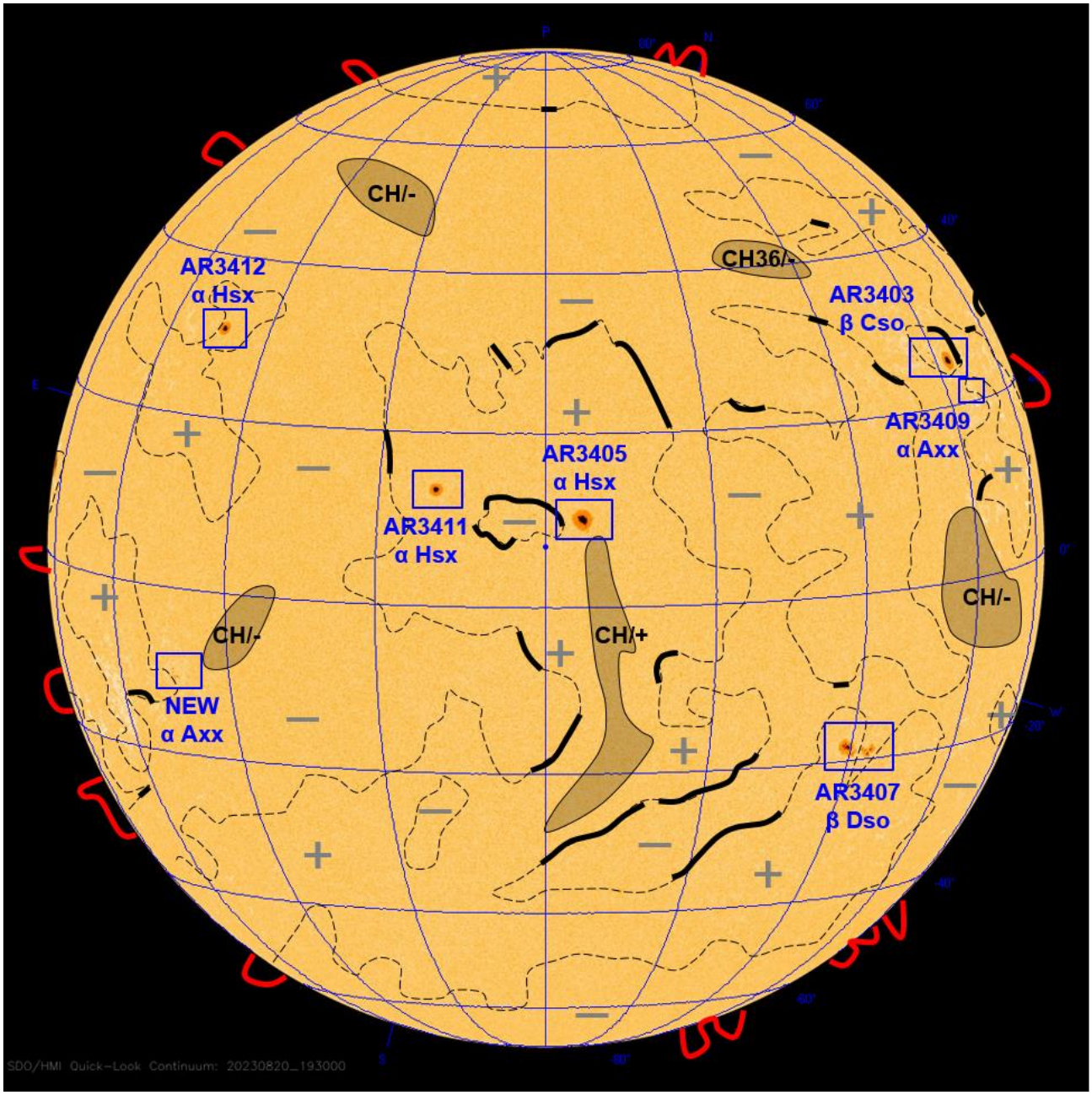
Figure 0. SDO HMI Intensitygram – Flattened at 20/2345 UTC showing AR3412 (top right) and returning Ex-AR3386 (lower left)



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 1. Solar Analysis Valid 20/1930 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

No Earth-directed CMEs currently feature in the forecast period. However, a large number of filaments occupy the Earth-facing disc of the sun and will be closely monitored for any destabilisation and potential lift-offs during the upcoming days.

Solar winds observed at L1 remain Strong with speeds varying between 600-670 km/s and a peak speed of 690km/s observed at 20/1200 UTC. It is speculated that this is due to the connection to a previously unidentified, negative polarity, trans-equatorial coronal hole around 50W and not the previously assumed influence of CH35/-, which is now approaching the western horizon. The duration of the connection to this newly identified feature is somewhat uncertain, but should be at or near its peak effect at L1. A gradual exit from this high speed stream (HSS) is expected in the coming days with speeds likely returning to Elevated or Slightly Elevated levels by the end of Day 2 (22 August). It should be noted that Enlil does not feature this HSS in its modelling and as such is unreliable in its forecast detail during the current period.

Following this the next recurrent HSS is a positive polarity coronal hole currently located around 10W, extending across the solar equator, but mainly in the southern hemisphere. This region is of large latitudinal extent, but very narrow longitudinal width. As such, confidence in the onset and duration of any connection to this feature is rather low but speeds of 500-570km/s (Elevated) were observed on the previous rotation and with the region appearing broadly similar to then, similar peak speeds should be observed. The most likely arrival time of this feature is on Day 3 (23 August), but its influence at L1 should start to weaken again on Day 4 (24 August). Enlil is also not modelling this HSS in its forecast for the period.

Geomagnetic activity is forecast to be mostly Quiet to Unsettled (Kp1-3) throughout, but on Day 1 and also Day 3 there is the Chance for isolated Active intervals and a non-zero risk of a G1/Minor Storm period should there be any protracted period of negative Bz on these days, especially given the enhanced solar winds indicated.

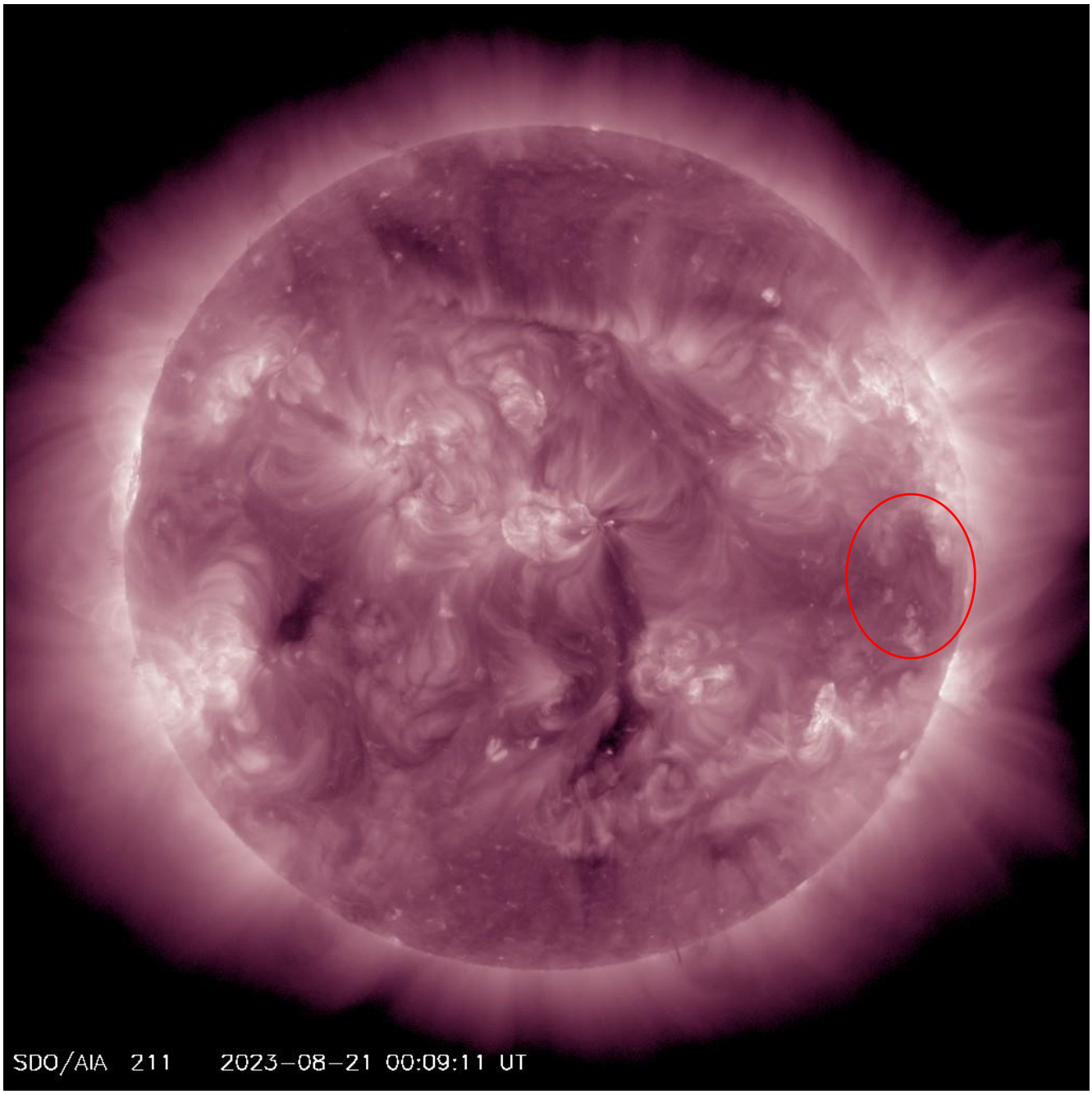
Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections – Nil

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

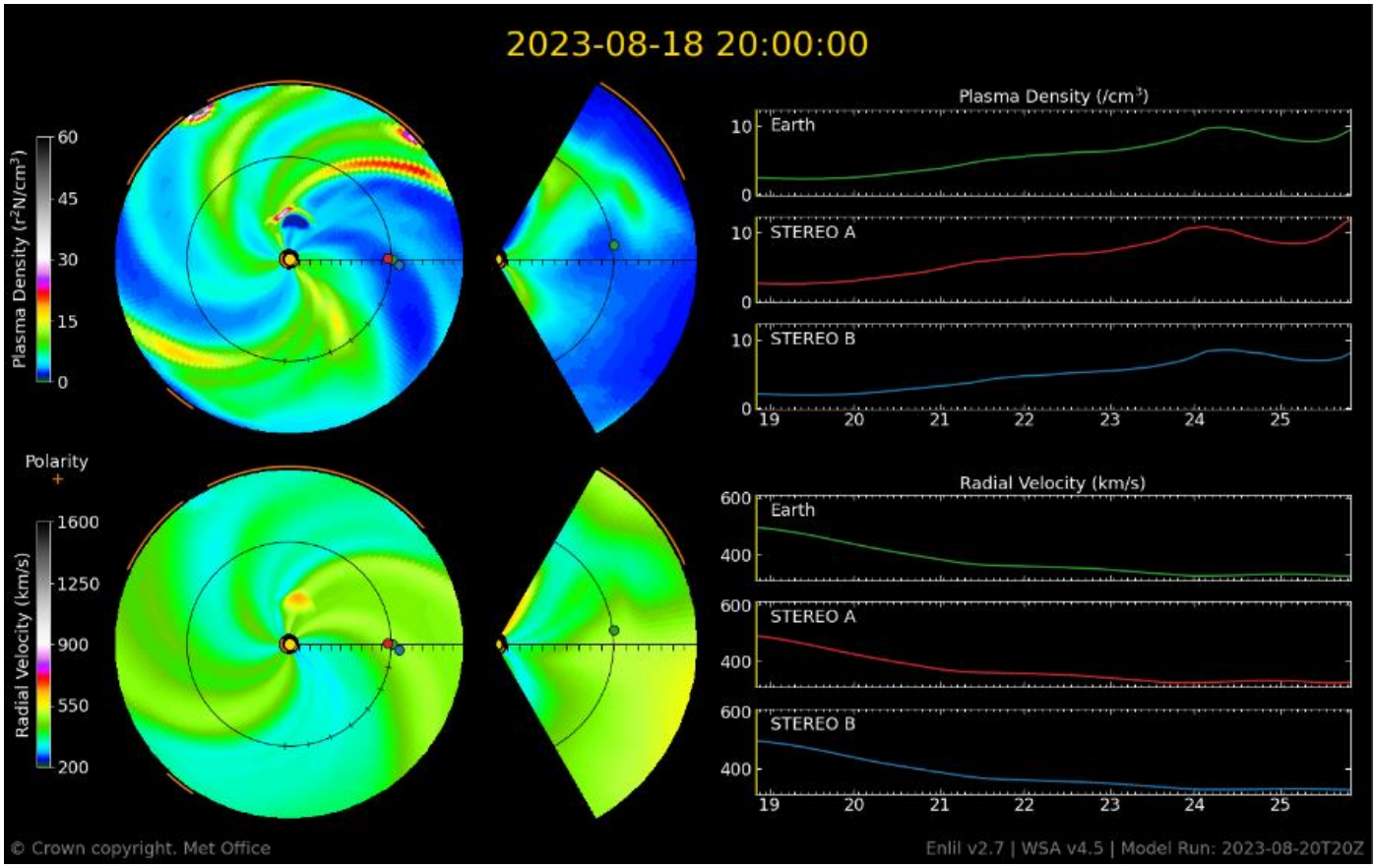
Figure 2. SDO/AIA 211 imagery from 21/0009 UTC. Circled is the previously unidentified CH thought responsible for the current Strong solar winds.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 3. Latest Enlil output from MOSWOC. Notice that observed winds are around 200km/s faster than modelled. An indication that the current HSS is not being accounted for, nor the reccurent feature expected on Day 3 and 4 (23 and 24 August)



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, with occasional mid-level C-class flares, peaking at C3.7 at 20/0626 UTC from the small area AR3409 in the northwest. The 10.7cm Penticton flux value is now relatively low at 151sfu (from a midweek high of 160) but is expected to rise with enhanced flux arriving over the eastern solar horizon in the coming days. This is likely to dictate a forecast uptick in activity into the new UTC week, despite the loss of AR3403 and AR3409 over the western limb.

Seven sunspot regions currently feature on the visible disc, with one unnumbered in the southeast. All are magnetically simple and stable at this time. A new, large region is just starting to appear over the eastern horizon in the northern hemisphere. This is the returning Ex-AR3386 that was responsible for an X1.6 flare on 05 August. It is possible that a survival here is part of the cause of the witnessed instability and CMEs released from its vicinity in the past 48 hours.

Another region just over the eastern limb presents some bright flux on EUV imagery in the southern hemisphere around 20S and may contain another sunspot group though this appears to be a non-recurrent feature.

Solar Activity is expected to be Low, but with a Chance of isolated M-class flares, especially considering the potential for flares from the new large region currently rotating over the eastern horizon.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux observed by GOES16 is expected to remain at Background levels. There persists an ongoing and very gradually increasing Slight Chance of proton flux increases from any significant flares, perhaps most likely from the western solar hemisphere, however these are considered very unlikely to reach S1 Minor Solar Radiation Storm levels.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	2	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux remains close to Normal Background levels. A potentially strong recovery in flux at GEO is probable as the HSS from the newly determined CH/- in the western hemisphere wanes on Day 1 and 2 (21 and 22 August), and also given the current lack of any significant geomagnetic activity. Current guidance is for diurnal peaks to reach Moderate, possibly High levels. Confidence in the forecast reduces by Day 3 (23 August) with the forecast onset of a positive polarity CH that could reduce electron counts at GEO, continuing into Day 4 (24 August) should geomagnetic activity increase as anticipated. MOSWOC REFM modelling does not account for this in its forecast, which is already well above observed values and is likely to be too high on all days of the forecast period. Therefore the associated 24-hour fluence forecast will start below the Active (1e8 integrated pfu), but with a probable upward trend between Days 1-3 until increased geomagnetic activity later in the period allows electron fluence to reduce again, but with lower than average confidence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	30	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 4: Latest GOES 16 >2MeV Electron flux (top) and associated Fluence with REFM and recurrence (below). Current observed fluence values are well below REFM expectations and not expected to account for the increased geomagnetic activity from Day 3 (23 August) and subsequent reducing in electron flux and fluence.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.